

## Effects of Synchronous and Asynchronous Approaches in Geometry Learning to Stimulate Students' Critical Thinking

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**Abstarct.** Geometry learning has an important role in stimulating critical thinking. During the Covid-19 pandemic, synchronous and asynchronous approaches became an alternative in geometry learning. The purpose of this study is to investigate the effectiveness of geometry learning by combining synchronous and asynchronous approaches in stimulating critical thinking. This study used a mixed design, namely quantitative and qualitative approaches. The sample was mathematics education students who had taken basic calculus and mathematical logic courses. Quantitative data collection used critical thinking worksheets and questionnaires to measure student activities and responses. Qualitative data collection through learning video recordings and researcher notes during learning. The results showed that student activity was high. Details can be explained in the discussion section.

**Keywords:** critical thinking skills, geometry learning, synchronous, asynchronous.

**Abstrak.** Pembelajaran geometri memiliki peran penting dalam menstimulasi berpikir kritis. Ketika pandemic Covid-19, pendekatan sinkronus dan asinkronus menjadi alternatif dalam pembelajaran geometri. Tujuan penelitian ini adalah menginvestigasi efektivitas pembelajaran geometri dengan mengkombinasikan pendekatan sinkronus dan asinkronus dalam menstimulasi berpikir kritis. Penelitian ini menggunakan desain campuran, yaitu pendekatan kuantitatif dan kualitatif. Sampel penelitian ini adalah mahasiswa pendidikan matematika yang telah menempuh matakuliah kalkulus dasar dan logika matematika. Pengumpulan data kuantitatif menggunakan lembar kerja berpikir kritis dan kuesioner untuk mengukur aktivitas dan respon mahasiswa. Pengumpulan data kualitatif melalui rekaman video pembelajaran dan catatan peneliti selama pembelajaran. Hasil penelitian menunjukkan aktivitas mahasiswa tergolong tinggi. Selengkapnya dapat dijelaskan pada bagian pembahasan.

**Kata kunci:** kemampuan berpikir kritis, pembelajaran geometri, sinkronous, asinkronous.

## **INTRODUCTION**

Various literature studies mention the importance of a person, including students, having critical thinking skills in the future. Critical thinking is vital for students in the 21st century (Halpern, 2002). Future education makes critical thinking the main goal of learning (Mason, 2008; Moon, 2008). Critical thinking is not only needed in classroom learning, but also many companies require graduates who are able to solve various problems with critical thinking, and are able to make smart decisions (Bassham, Irwin, Nardone, & Wallace, 2018). Therefore, critical thinking should be a goal in learning, especially mathematics learning.

Geometry is an important field of mathematics to be taught at every level of education (Celik & Yilmaz, 2022; Naufal, Abdullah, Osman, Abu, & Ihsan, 2021). Geometry is needed in many fields, such as astronomy, architecture, engineering, and physics (Silmi Juman, Mathavan, Ambedgedara, & Udagedara, 2022). The purpose of teaching geometry is to develop critical, creative, analytical, and systematic thinking (Kemendikbud, 2013) in solving simple problems (Celik & Yilmaz, 2022), and developing spatial orientation (Markovits & Patkin, 2020). In fact, the majority of students have difficulty learning geometry (Naufal et al., 2021; Silmi Juman et al., 2022). This fact is shown through the Indonesian TIMSS results which always get unsatisfactory results. Only 25% of students answered correctly to geometry questions (Hadi & Novaliyosi, 2019). This is because teachers often ignore meaningful geometry learning at the beginning of school (Clements & Sarama, 2011). Therefore, geometry learning needs to get serious attention in order to achieve the expected goals, especially students are able to think critically.

Critical thinking in learning geometry is very necessary (Silmi Juman et al., 2022). People who think critically have the opportunity to achieve a better life (As'ari, 2016; Biber, Tuna, & Incikabi, 2013; Chukwuyenum, 2013; Uarattanaraksa, Chaijareon, & Kanjug, 2012; Yeh, 2009). Critical thinking means the cognitive process of making logical decisions (Ennis, 1996; Facione, 1990). Before making a decision, people who think critically will always seek the truth and think openly to all other people's points of view (As'ari, Kurniati, Maharani, &

Basri, 2019; Biber et al., 2013). The importance of critical thinking, then learning geometry should be developed to stimulate critical thinking.

Geometry learning that can stimulate critical thinking is needed in the covid-19 pandemic situation. Almost all teachers carry out geometry learning online. There are two approaches that are widely used in online learning, namely synchronous and asynchronous. Several studies compared the two approaches. The results of previous studies show that students prefer and are interested in learning with a synchronous approach (Flynn-Wilson & Reynolds, 2020; Malik, Fatima, Ch, & Sarwar, 2017). However, the synchronous approach is not free from drawbacks, namely communication barriers due to technology limitations and large class sizes that make it difficult to supervise each individual (Vale, Oliver, & Clemmer, 2020). In contrast, the asynchronous approach results in the achievement of higher cognitive levels (Mairing, Sidabutar, Lada, & Aritonang, 2021), students are required to be able to learn independently (Lin & Gao, 2020). In addition, students can learn anywhere and anytime (Mairing et al., 2021).

Some studies show the use of the two approaches separately, i.e. using synchronous only or asynchronous only. The advantages shown by the two approaches should be able to complement each other, so that the synchronous and asynchronous approaches can be combined in learning (Mairing et al., 2021). Therefore, learning geometry by combining synchronous and asynchronous approaches needs to be further investigated whether it produces a positive impact on student behavior and critical thinking skills. Therefore, the purpose of this study is limited to determine student activity towards geometry learning that uses synchronous and asynchronous approaches in stimulating student critical thinking. The results of this study are expected to be one of the alternatives for teachers to stimulate critical thinking through a combination of two learning approaches, namely synchronous and asynchronous.

### **Research Methods**

This research uses two approaches, namely quantitative and qualitative or better known as mixed method. Mixed methods are used to gain a comprehensive

understanding of the research problem (Creswell, 2012). The quantitative approach uses a one-group posttest-only design.

The sample of this research was students of mathematics education study program of FKIP Unissula who had taken calculus and mathematical logic courses. Sampling using purposive random sampling. Data collection instruments in the form of worksheets, questionnaires, and math tests, especially in the field of analytic geometry. Worksheets were given to determine the development of students' critical thinking. The questionnaire used consists of two, namely a student response questionnaire and a student activity observation questionnaire. The math test was given at the last meeting to determine the level and quality of critical thinking. Before the instruments were used in the research, the instruments were validated first to experts in the field of mathematics learning.

After the data were collected, the data were analyzed for each meeting which included quantitative data analysis and qualitative data. Quantitative data analysis using descriptive statistics, including (1) data analysis of student answers on worksheets using a holistic assessment rubric with indicators of concept mastery, completion of problem exercises, completion of problem understanding activities, and problem solving activities, (2) data analysis of student response questionnaires and student activity observations carried out by calculating the scores obtained, and (3) data analysis of mathematics test answers. Qualitative data analysis is used to analyze the results of learning recordings and notes during learning with stages: (1) organizing data, (2) transcribing data, (3) labeling important transcripts, (4) presenting data, and (5) concluding.

## **RESULTS AND DISCUSSION**

Geometry learning is implemented for three meetings using a combination of two approaches, namely synchronous and asynchronous for each meeting. First, students carry out geometry learning with an asynchronous approach. Lecturers use Google Classroom to upload the Student Worksheet (LKM). Students are formed into several groups. Each group consists of 3-4 students. Each group is asked to work on the LKM. Each meeting, the LKM given has a different and structured

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subject matter. The subject matter of the LKM at the first to the third meeting is the distance between two points, line equations, and line files, respectively. The LKMs provided contain activities that must be completed by each group, namely training activities to understand the material, understand the problem, ask questions, seek information, solve, make conclusions, reflect, and independent practice. In the asynchronous approach, students are asked to complete the exercise activities of understanding the material, understanding the problem, asking questions, seeking information, solving, and making conclusions.

In the synchronous approach, each group of students discusses the answers to each activity, and then presents the results of the solution and the conclusions that are determined. Lecturers and students carry out learning through GoogleMeet. After one group presented, other groups were asked to respond. While students are discussing, presenting the results of the discussion, and conducting questions and answers, the lecturer observes, analyzes, and writes important notes to be conveyed to students, as well as material for reflection. After the question and answer time is over, the lecturer responds to the students' answers. Before the lesson ends, the lecturer asks the students to reflect on the results of each activity. At the end of the lesson, the lecturer asked each student to complete an independent exercise as a stabilization material.

Student activities during synchronous learning were observed by two observers. Each observer joined the GoogleMeet and observed the students' activities from the beginning to the end of the lesson. There were eight statements that were assessed by the observers based on their observations. The following are the results of observers' observations of student activities during Geometry learning.

No.	Aspects assessed	P1		P2		P3		Rata-rata
		O1	O2	O1	O2	O1	O2	
1	Confirm the LKM has been completed and collected.	3	3	3	4	3	4	3,33
2	Communicate and explain students' understanding of mathematical problems.	3	4	3	4	4	4	3,67

No.	Aspects assessed	P1		P2		P3		Rata-rata
		O1	O2	O1	O2	O1	O2	
3	Articulate and explain the critical questions used to explore the math problem.	3	4	4	3	3	4	3,50
4	Convey and explain relevant information used to solve math problems	3	4	4	4	4	4	3,83
5	Conveying other ideas or thoughts about the answers to the activities in LKM	3	4	4	4	3	4	3,67
6	Deliver and explain in detail the answers to activity 4: solving the math problem, and activity 5: conclusion on solving the math problem.	2	4	3	4	3	4	3,33
7	Conduct classical discussions and questions and answers	2	4	3	4	3	4	3,33
8	Reflect and convey the results of reflection on the completion of activities 1-5 on LKM.	2	4	3	3	4	4	3,33
Rata-rata								3,50

**Tabel 1. The results of the observer's observations of student activities during Geometry learning.**

Information:

O1 = First observer      P1 = First lesson  
O2 = Second observer    P2 = Second lesson  
P3 = Third lesson

The results of observers' observations of student activities during Geometry learning in Table 1 show that student activities in learning have met the criteria of being very active. The average of each aspect of student activity shows a score of more than 3.00. This shows that the observer assessed that most students participated very actively in each phase. Student activeness during learning with a synchronous approach is in line with (Flynn-Wilson & Reynolds, 2020; Malik et al., 2017) who said that students are more interested and comfortable following learning with a synchronous approach. Student interest is shown by attendance

which is close to 100%. Students' comfort is shown by their response that students do not need to go to class and travel far, and do not spend much money.

Nevertheless, the researcher noted some weaknesses during synchronous learning, namely the answers of students in one group were relatively the same, only a few students were active in asking questions and responding, and only a few students activated the camera. The weaknesses in synchronous learning are in line with the results of research (Aslan, 2021; Karim, 2021; Lin & Gao, 2020) which mention many challenges that become weaknesses in learning with a synchronous approach, including the influence of different internet speeds and only a few students who actively ask and respond. Almost all students asked questions in writing in the questioning activity. However, few students actively asked questions directly during the learning process. Students who ask questions are usually group leaders.

## **CONCLUSION**

Student activity in learning Geometry using a combination of synchronous and asynchronous approaches classified as very active. These results indicate that the combination of the two approaches can be applied in learning geometry, especially stimulating student activeness. Therefore, researchers give advice to use a combination of these two approaches. Nevertheless, there are aspects that have not been explained in this study, such as student responses and student critical thinking results.

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